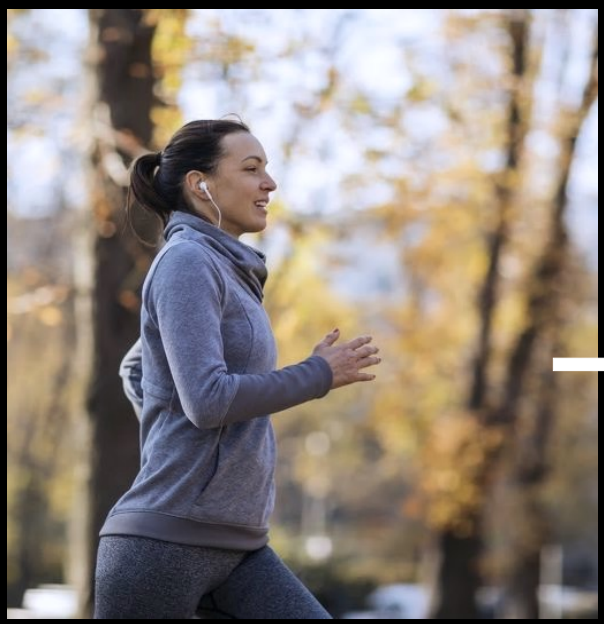
Overview

- Technology x Sports: Extended Reality and Sports
- Gaming x Sports: Exergames
- How to: Exergame Design, Research and Implementation
- Conclusion

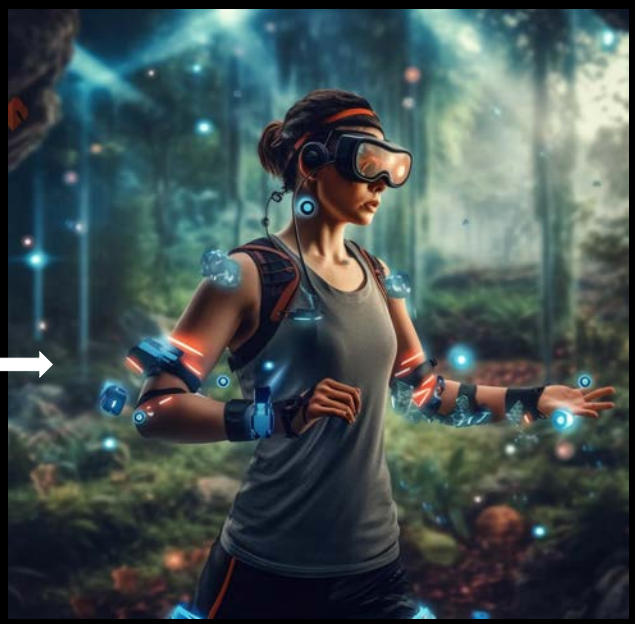
3

Kontakt: anna.martin@zhdk.ch

TECHNOLOGY x SPORTS



(iStockphoto)



(created with midjourney.com)

EXTENDED REALITY (XR)

Virtual Reality (VR) // Augmented Reality (AR) // Mixed Reality (MR)

(Modified after: Milgram & Colquhoun, 1999)

Augmented Reality Sports

Sports–Agility AR

Augmented Reality Sports

Ghost Pacer

Virtual Reality Sports

Tennis Esports

Mixed Reality Sports

Eon Sports

But…

Tenor.com

SWEET SPOT OF IMMERSION…

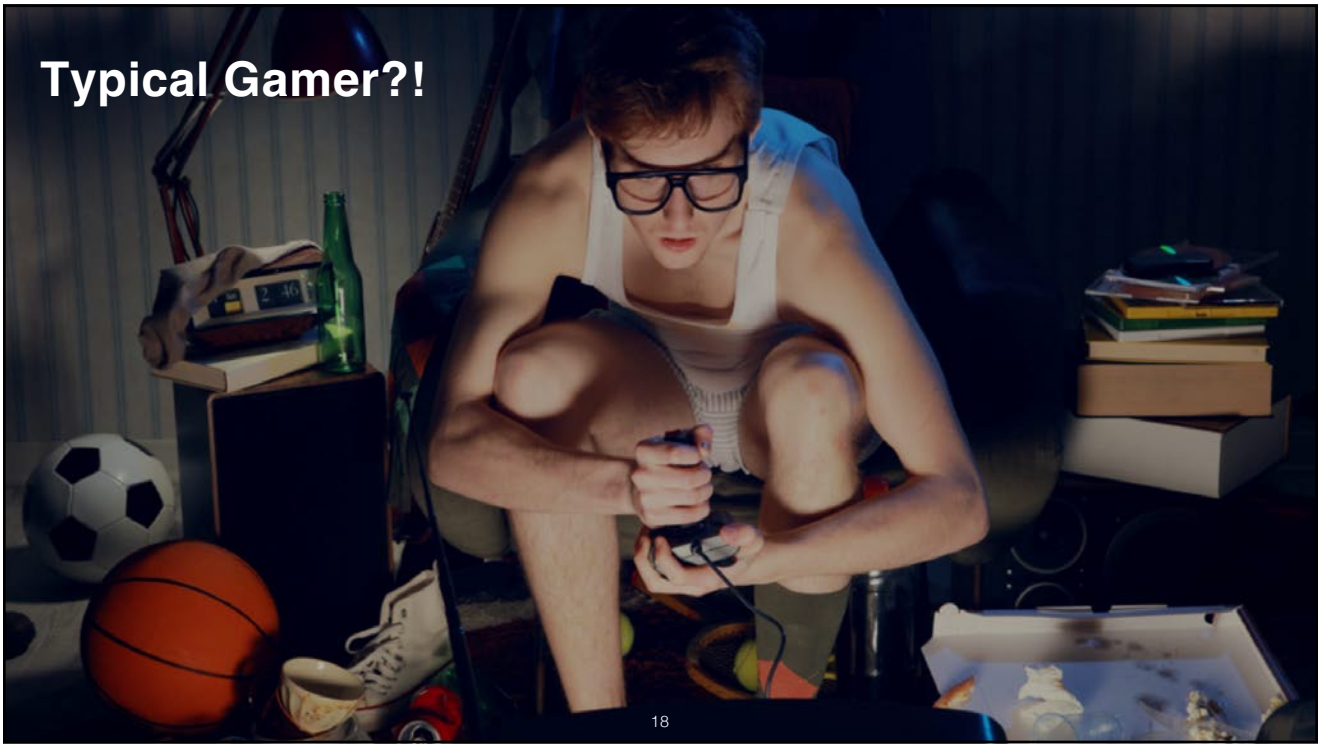
DESIGN GUIDELINES…

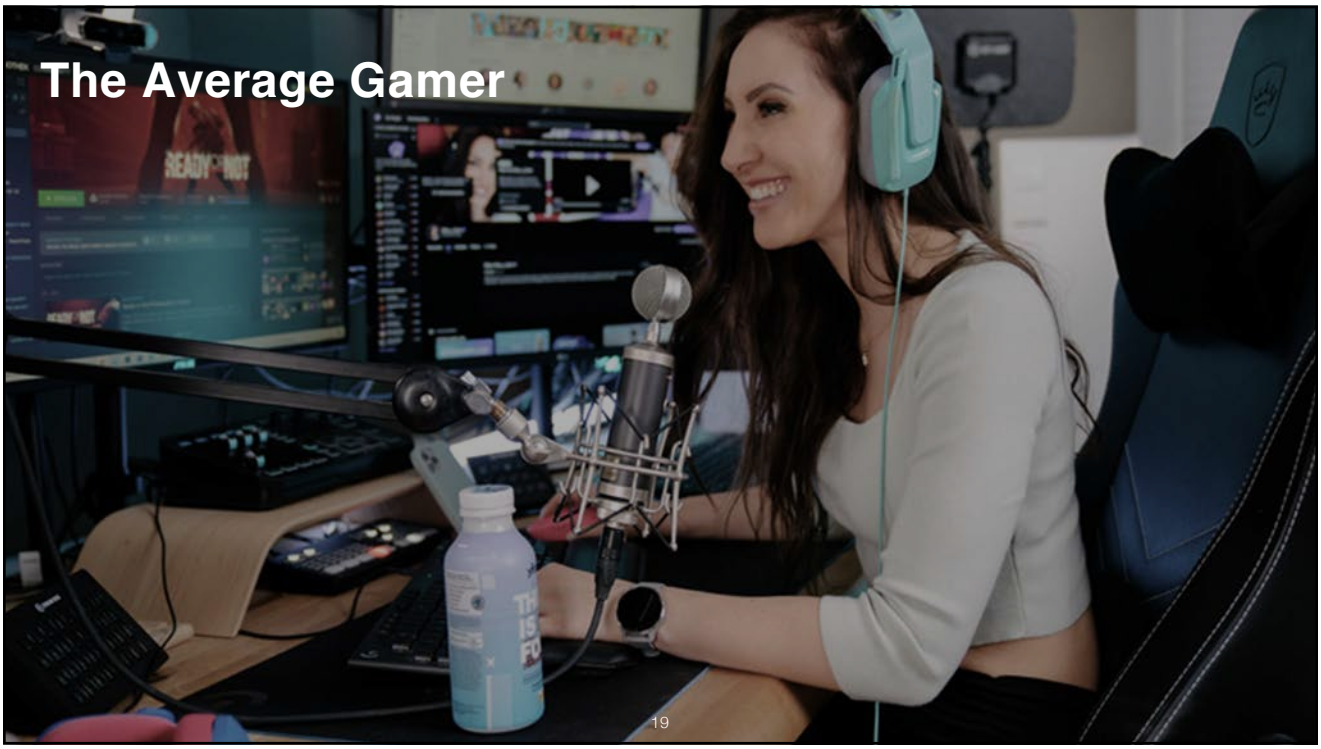
- Focus on the needs of users.
- Make the technology easy to use.
- Allow for personalization.
- Ensure safety and data protection.
- Allow for integration with other technologies.
- Make the technology accessible to all users.
- Collaborate across disciplines.
- Provide feedback and motivation.

MOTIVATION…

8 BILLION PEOPLE
3.7 GAMERS
1.5 PHYSICALLY ACTIVE

HOMO LUDENS?!


Typical Gamer?!


The Average Gamer


The Cognitive Athlete
ALIENWAR
Windows 10
G2A
NVIDIA
ESL

20


Cognitive Athletes

21

GAMIFICATION

«The use of game-elements and game-design techniques in non-game contexts.»
(K. Werbach & D. Hunter)

SERIOUS GAMES

«Games with a purpose beyond fun.»
(K. Werbach & D. Hunter)

DEEP VR

That Dragon Cancer

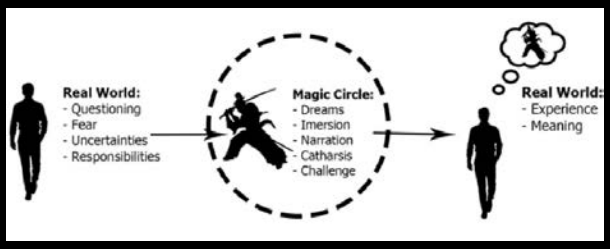
Re-Mission

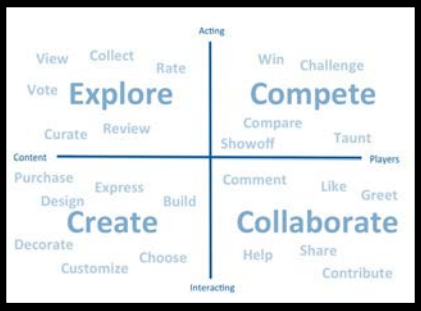
Body Swap

Gameplay Experience: Theories & Models

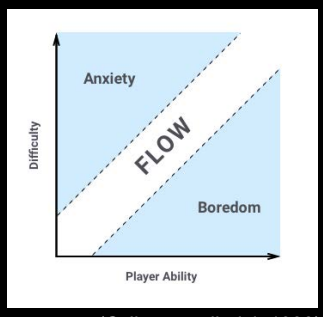
«Spiel ist eine freiwillige Handlung oder Beschäftigung, die innerhalb gewisser festgesetzer Grenzen von Zeit und Raum nach freiwillig angenommenen, aber unbedingt bindenden Regeln verrichtet wird, ihr Ziel in sich selber hat und begleitet wird von einem Gefühl der Spannung und Freude und dem Bewusstsein des *Andersseins* als das *gewöhnliche Leben*.»

(Johan Huizinga, Homo Ludens – Vom Ursprung der Kultur im Spiel, 1938, S. 37)

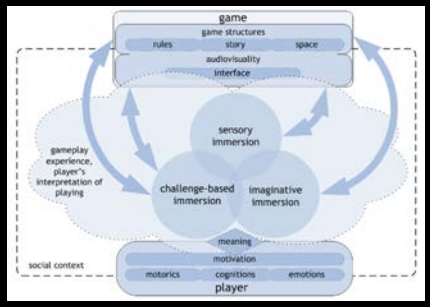




(Bartle, 1996)



(Csikszentmihalyi, 1990)

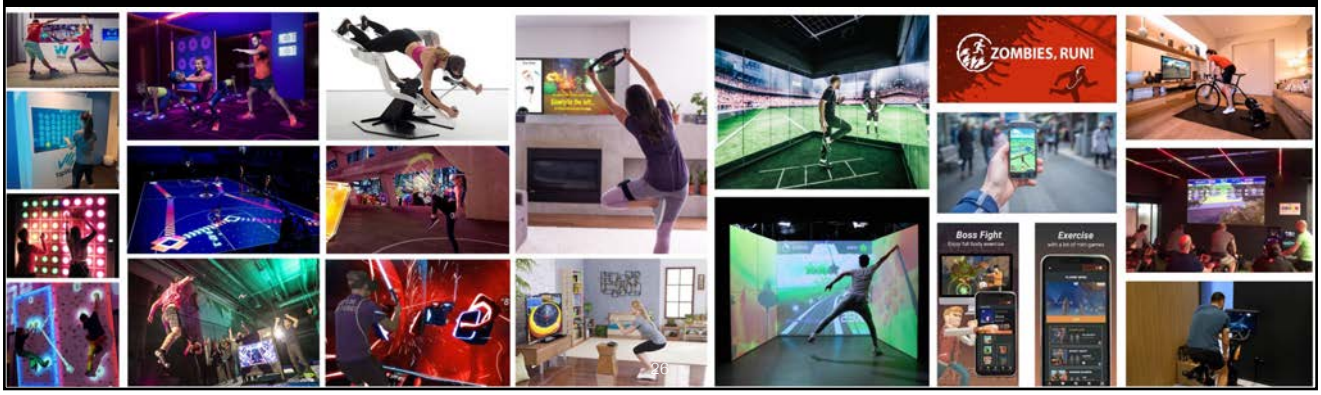


(Ermi & Mäyrä, 2005)

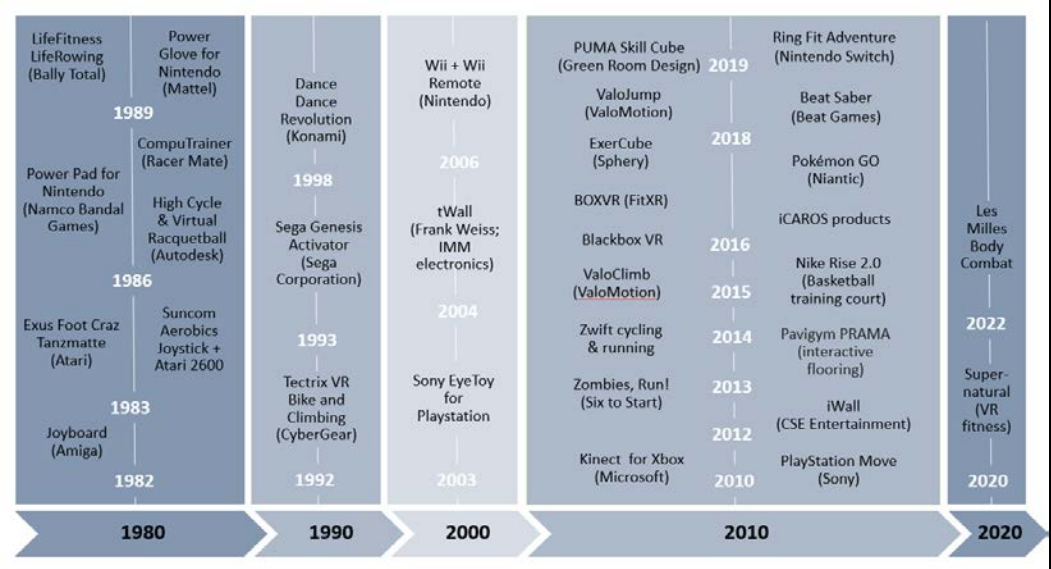
GAMING x SPORTS

EXERGAMES

(Exercise + Gaming)

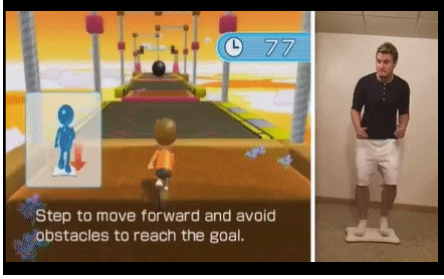


Exergame History



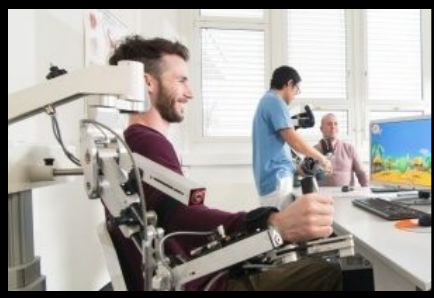
(Röglin, Martin-Niedecken & Ketelhut, in press)

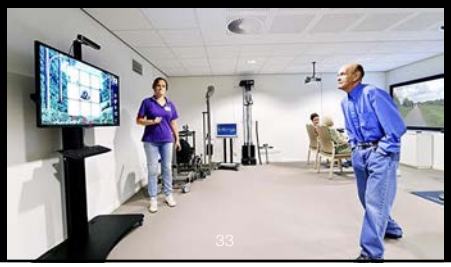
Exergames @home



Game-based Rehabilitation



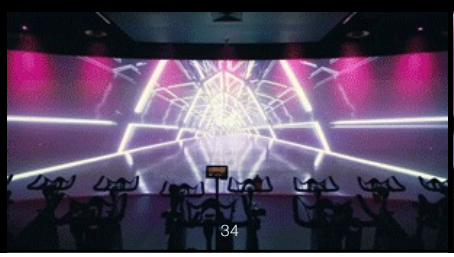





VR Fitness – Immersive Fitness – Gamified Fitness

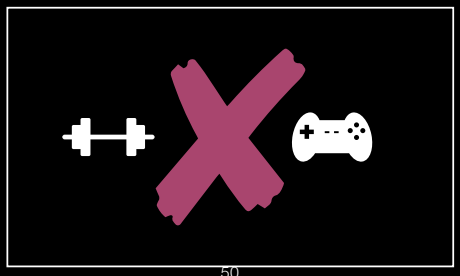


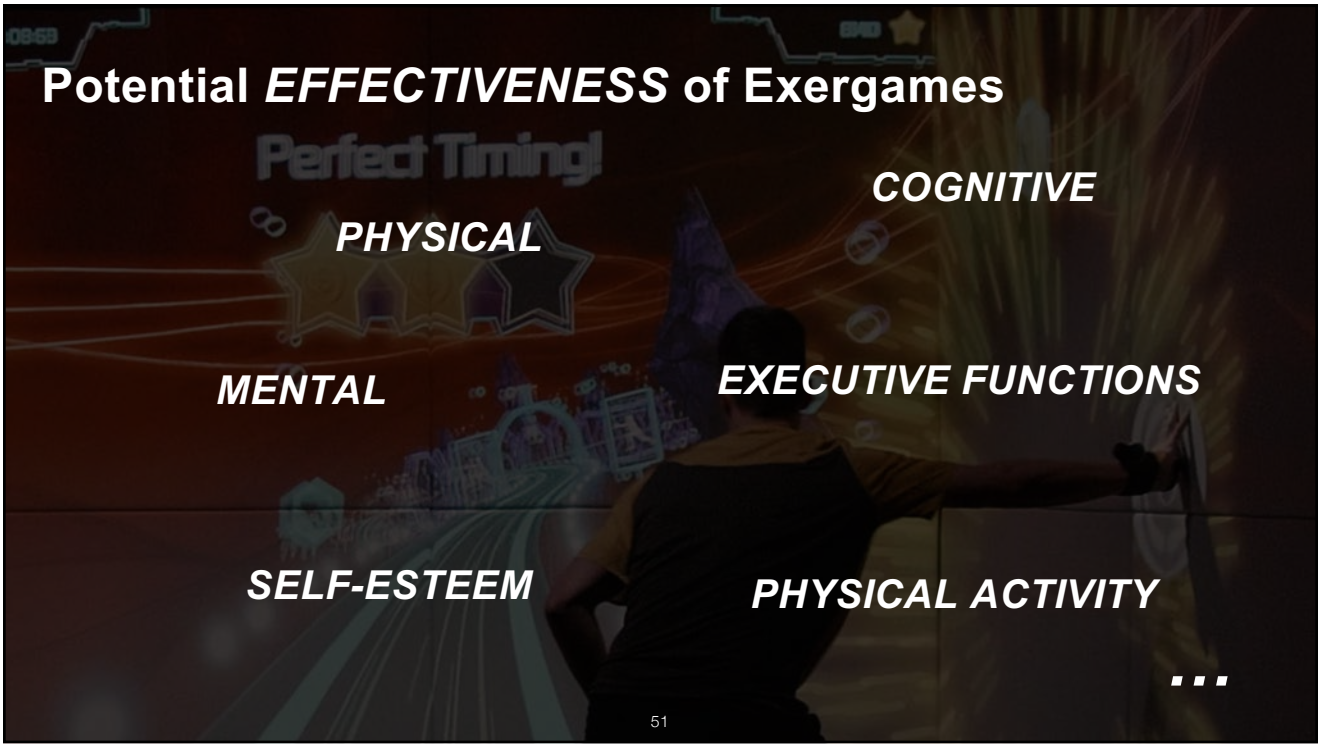


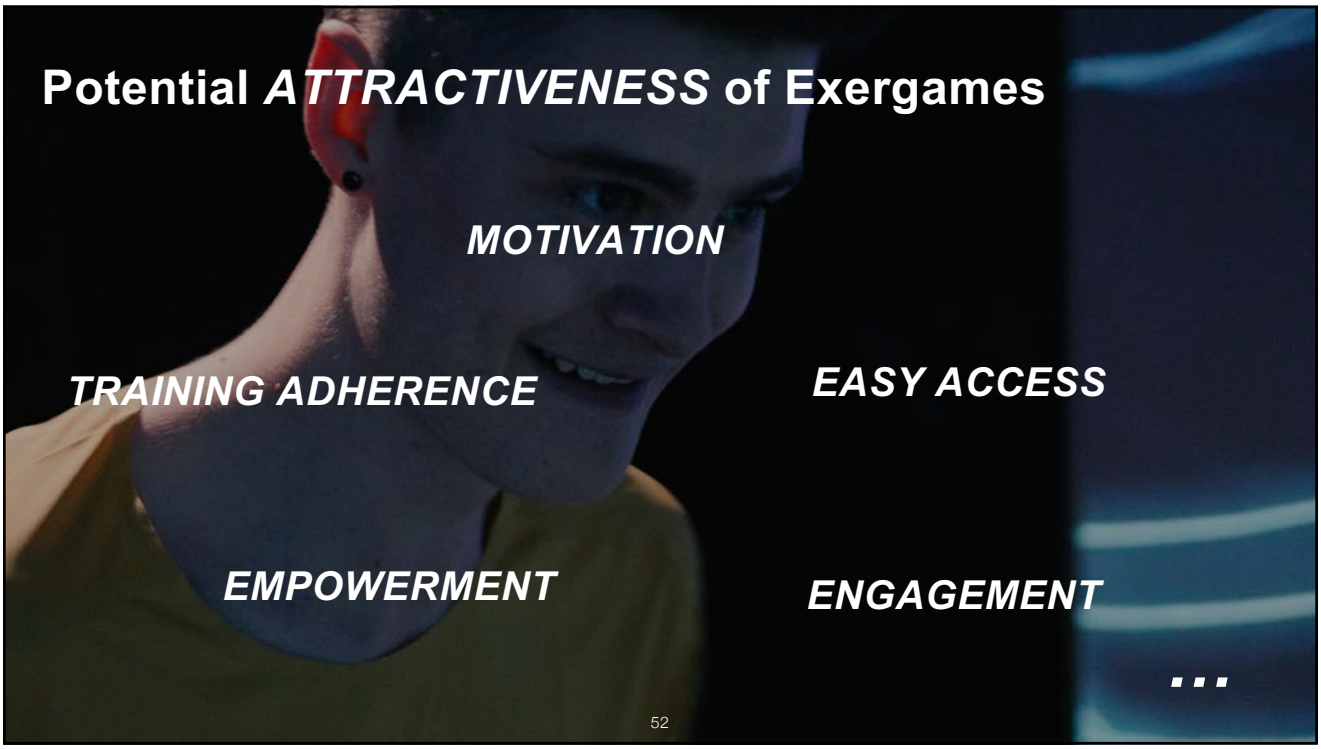


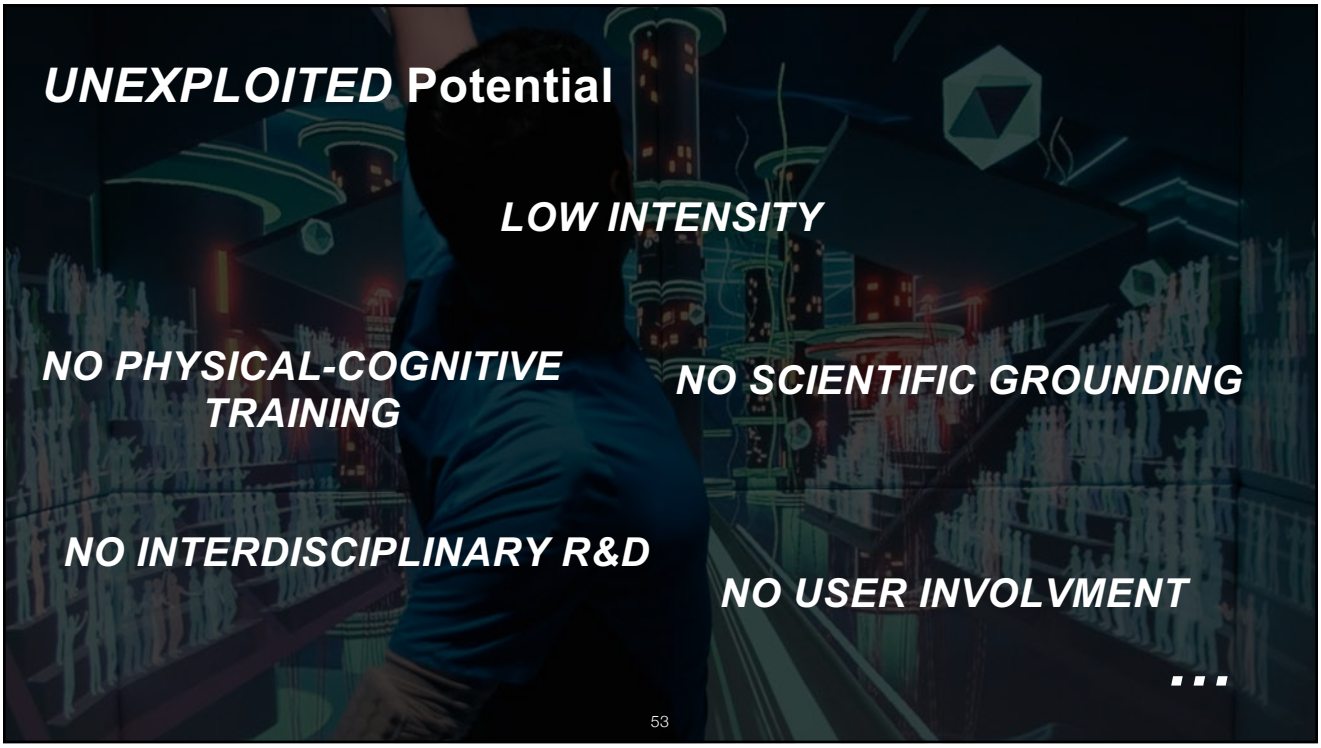

FROM SPORTIFICATION OF GAMES TO GAMIFICATION OF SPORTS

What's missing?



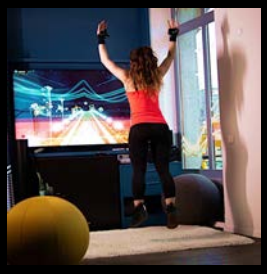

Potential *EFFECTIVENESS* of Exergames
Perfect Timing!
COGNITIVE
PHYSICAL
MENTAL
EXECUTIVE FUNCTIONS
SELF-ESTEEM
PHYSICAL ACTIVITY
...
51


Potential *ATTRACTIVENESS* of Exergames
MOTIVATION
TRAINING ADHERENCE
EASY ACCESS
EMPOWERMENT
ENGAGEMENT
...
52



HOW TO: ATTRACTIVE & EFFECTIVE EXERGAMES

Project Overview

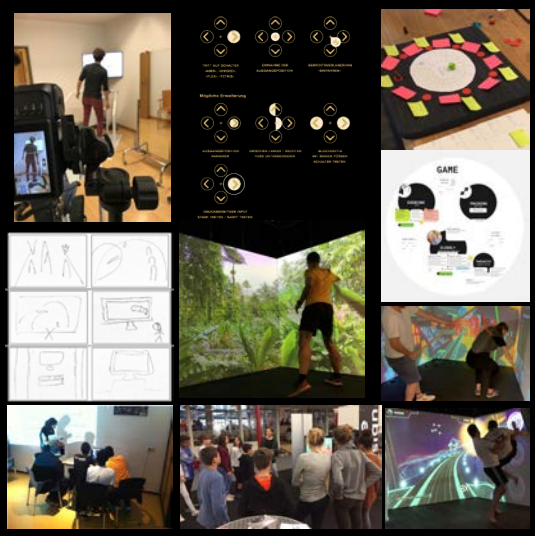



INTERDISCIPLINARY, USER-CENTERED, RESEARCH-BASED & ITERATIVE DESIGN PROCESS

Exergame Design Levels

User-Centered, Interdisciplinary Design Methods

- Focus Groups
- Co-Creation Workshops
- Walkthrough
- Participatory Observation
- Research through Design
- Body Storming
- Technical Exploration
- Field Testing
- Lab Studies
- etc.



SENSO EXPLORIA

R&D Projects (2018-2021) / supported by Innosuisse

Senso Exploria: User-centered Exergames for MS Patients

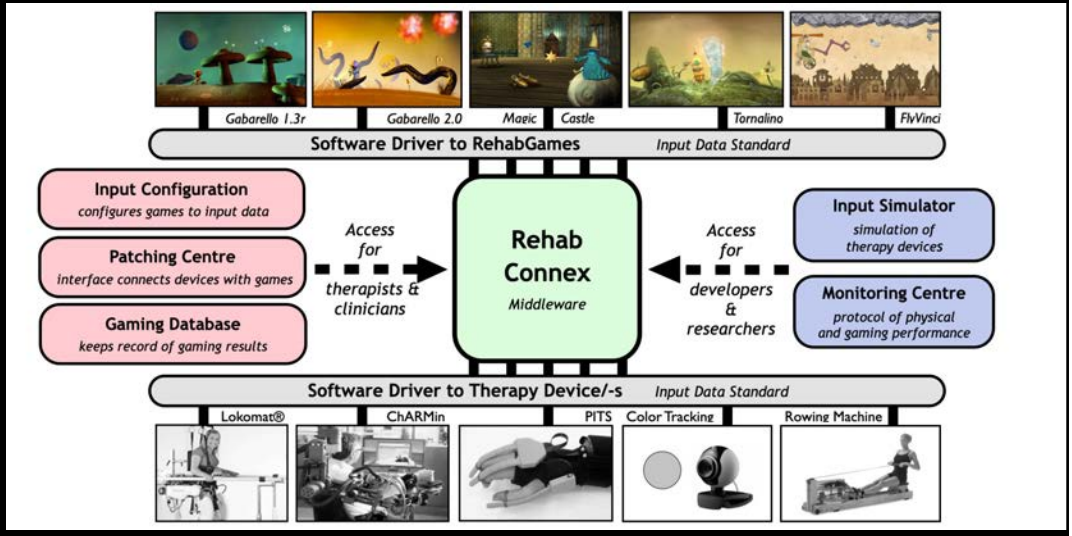
(Schättin et al., 2021)

IMIC

INNOVATIVE MOVEMENT THERAPY IN CHILDHOOD

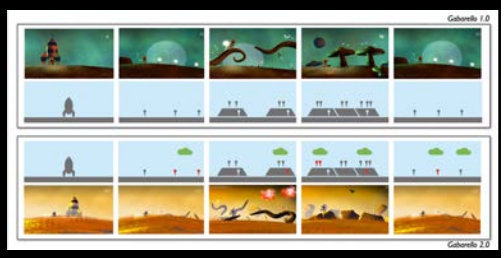
R&D Project (2008-2015) / supported by Mäxi Stiftung

IMIC: Game-Based, Robot-Assisted Movement Therapy



(Martin-Niedecken et al., 2015)

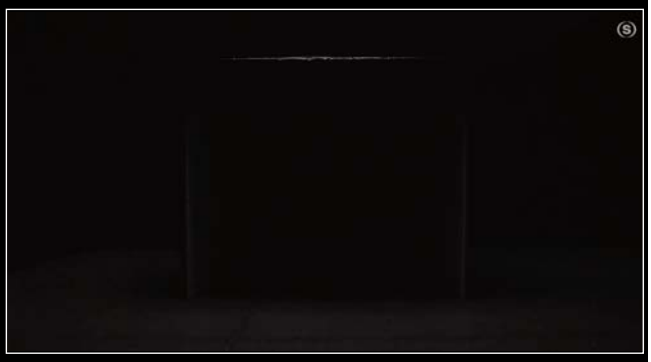
IMIC: Player Experience Journey



(Martin-Niedecken et al., 2015)

IMPACT OF DIFFERENT DESIGN PARAMETERS

«Plunder Planet» & «The ExerCube»



MOVEMENT CONCEPT

Movement Concept

AUDIO-VISUAL, NARRATIVE DESIGN & MECHANICS

Game Scenarios & Mechanics

CONTROLLER

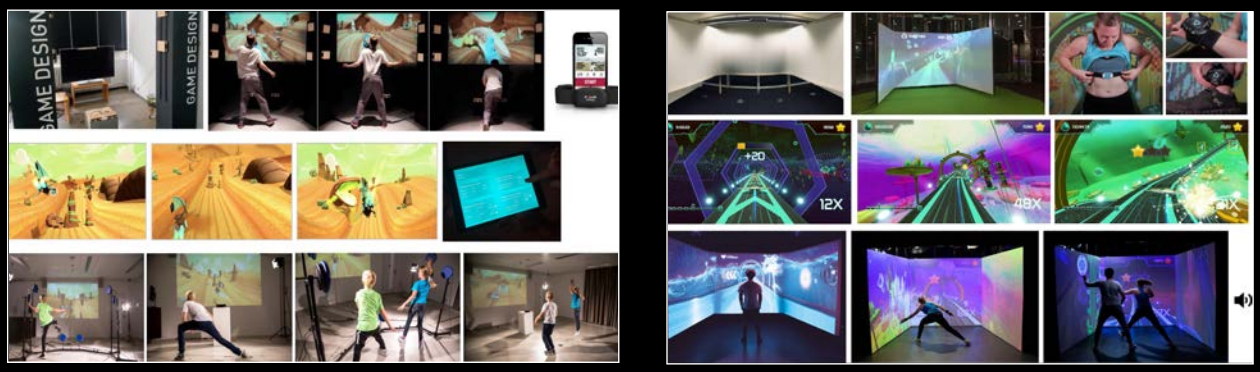
Controller

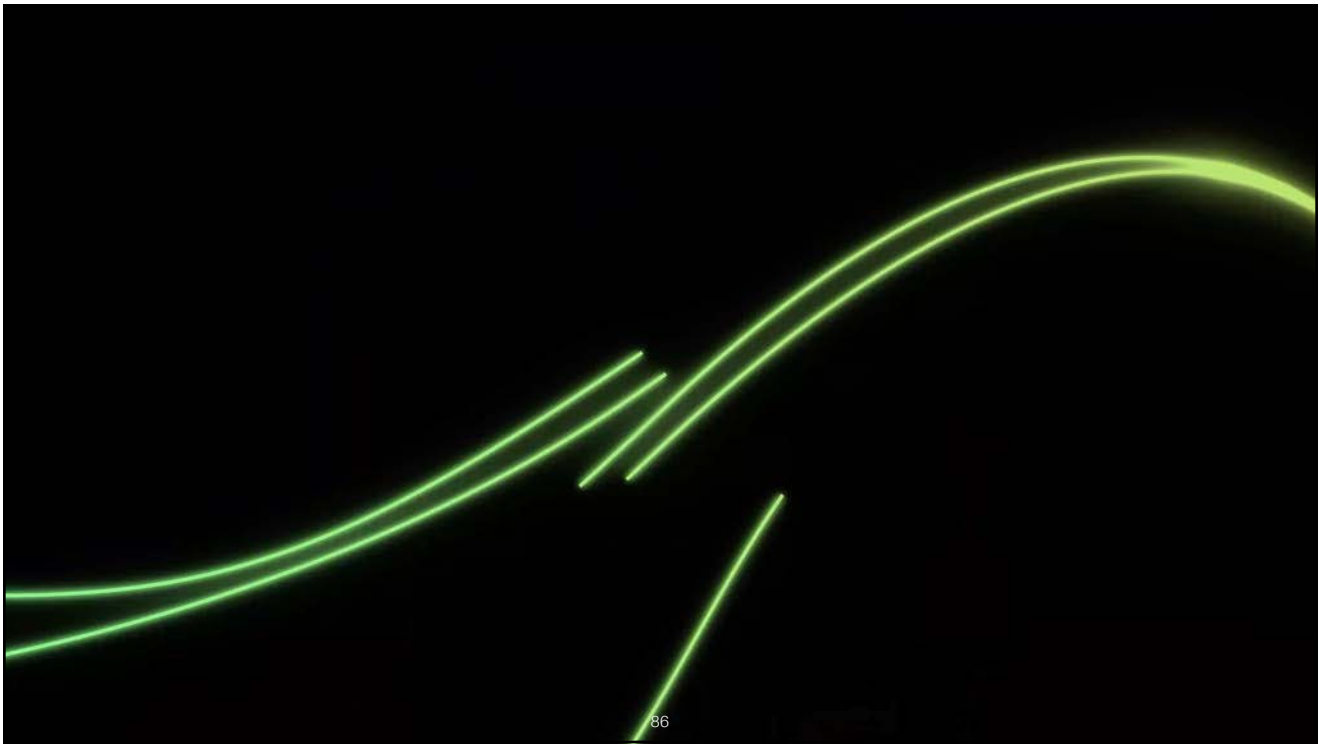
FULL-BODY-MOTION CONTI FBMC

PLAYER MODE

Player Mode

Research-Based, User-Centered Design Iterationen





International Research Network

UNIVERSITY OF WATERLOO

University of Basel

UPPSALA UNIVERSITET

UNIVERSITÄT BERN

ETH zürich

TECHNISCHE UNIVERSITÄT CHEMNITZ

TECHNISCHE UNIVERSITÄT DARMSTADT

CHARITÉ UNIVERSITÄTSMEDIZIN BERLIN

zh aw

Aalto University

uc3m | Universidad Carlos III de Madrid

Aix*Marseille université Socialement engagée

INSELGRUPPE

...

EVALUATE & ADAPT

Impact of…

MOVEMENT CONCEPTS

CONTROLLER FEATURES

MOTOR-COGNITIVE CHALLENGES

PLAYER MODES

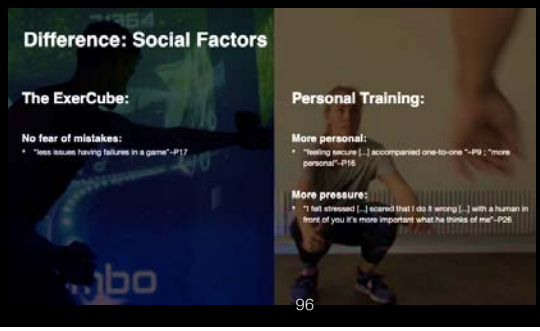
PLAYER-CENTRIC ADAPTATION

EMPOWERMENT

…

ExerCube vs. Personal Trainer

ExerCube vs. Personal Trainer – Subjective Experience



PT:
- Player's focus more on own body
- Stronger physical exertion
- Social preasure

ExerCube:
- Less physical exertion
- Stronger cognitive exertion
- «feel free»

(Martin-Niedecken et al. 2019)

Comparison of Effectiveness

	ExerCube	Traditional fHIIT	z	p	r
Average HR [bpm]	155.0 [141.5; 161.3]	159.5 [150.3; 167.0]	-2.878	.003*	0.46
Average HR (% of calculated HR_{max})	78.7 [72.6; 82.2]	81.1 [77.9; 85.8]	-2.837	.005*	0.45
Maximal HR [bpm]	182.5 [172.0; 191.0]	180.5 [176.0; 190.8]	-0.262	.806	0.04
Maximal HR (% of calculated HR_{max})	93.0 [88.7; 97.4]	91.6 [93.6; 97.3]	-0.302	.388	0.05
	ExerCube	**Traditional fHIIT**	**z**	**p**	**r**
$Borg_{physical}$	7.0 [6.0;8.0]	9.0 [8.0;9.0]	-3.020	.001*	0.48
$Borg_{cognitive}$	6.5 [5.0; 8.0]	5.0 [4.0; 6.0]	-1.603	.113	0.25

***=p<.05=significant**

ExerCube:
- slightly lower physical exertion BUT average heart rate reached the functional HIIT threshold
- subjectively experienced higher cognitive load (dual-domain training)

(Martin-Niedecken et al. 2020)

Comparison of Attractiveness

Questionnaires		ExerCube	Traditional fHIIT	z	p	r
SIMS	intrinsic motivation	6.5 [5.8; 6.8]	5.1 [4.5; 5.5]	-3.566	<.001*	0.56
	identified regulation	6.3 [5.5; 6.7]	6.0 [5.6; 6.7]	-0.029	>.999	0.01
	external regulation	1.3 [1.0; 2.4]	1.6 [1.3; 2.7]	-0.940	.367	0.15
	amotivation	1.0 [1.0; 1.6]	1.3 [1.0; 1.9]	-0.939	.388	0.15
FSS	overall	6.0 [5.6; 6.4]	5.4 [4.9; 5.8]	-3.663	<.001*	0.58
	fluency of performance	6.3 [5.5; 6.5]	5.7 [5.2; 6.4]	-1.708	.088	0.27
	absorption by activity	6.0 [5.5; 6.5]	4.9 [4.5; 5.8]	-3.436	.001*	0.54
	perceived importance	1.7 [1.0; 2.2]	1.0 [1.0; 1.8]	-2.519	.012*	0.40
PACES		6.3 [6.0; 6.6]	5.0 [4.7; 5.5]	-3.884	<.001*	0.61

***=p<.05=significant**

- **ExerCube:** sig. better results for flow, enjoyment & motivation

(Martin-Niedecken et al. 2020)

Embodied Sketching – Multiplayer Makeover

- Differentially balanced experiences of social immersion, fun & physical and cognitive exertion
- Identification of promising new player formations

(Martin-Niedecken et al., 2019)

EVALUATE

Investigation of ….

COGNITIVE(-MOTOR) FUNCTIONS

ANTROPOMETRIC PARAMETERS

PHYSICAL FITNESS

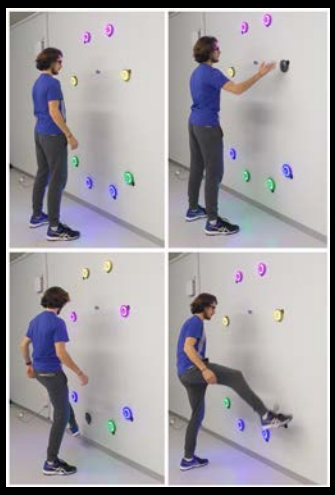
EXECUTIVE FUNCTIONS

…

ExerCube Training in Young Athletes





AIM: Gathering insights into the training effects of the ExerCube on cognitive(-motor) functions in young game athletes.

Results – Non-Randomized Controlled Trial

- 24 young game sports athletes (15 ± 0.7 years; 46% girls)
- 10 weeks intervention time → shortened to 8 weeks (due to pandemic restrictions):
  – Intervention group: 2x 25min ExerCube training per week + sports-specific training
  – Control group: Sports-specific training only
- Sig. positive effects on cognitive (motor) skills (faster reaction times), especially on concentration (U=-2.483, p=0.013, r=0.51), cognitive flexibility (F=12.176, p<0.001, d=1.488), and divided attention (F=9.776, p=0.002, d=1.404).

(Martin-Niedecken et al., 2023)

ExerCube @School

AIM: Investigation of effects of a school-based exergame intervention on anthropometric parameters and physical fitness

Results – Randomized Controlled Trial

- 58 students (10.4 ± 0.8 years; 48% girls) → only 34 students included in final analysis (due to pandemic restrictions)
- 3 month intervention time:
  – Intervention group: 2x 20min ExerCube training per week + physical education classes
  – Control group: Physical education classes only

Outcome	IG (n = 18)		CG (n = 16)			
	Pre	Post	Pre	Post	p-Values	η^2
BMI ($kg \cdot m^{-2}$)	21.7 ± 4.0	21.6 ± 4.2	19.3 ± 4.1	19.7 ± 4.1	n.s.	0.063
WHtR	0.47 ± 0.05	0.46 ± 0.05	0.44 ± 0.07	0.45 ± 0.07	n.s.	0.114
CMJ (cm)	18.6 ± 5.4	21.1 ± 5.2 ***	20.5 ± 5.2	18.6 ± 3.6 **	<0.001	0.403
ST (s)	4.12 ± 0.45	4.08 ± 0.47	4.06 ± 0.35	4.18 ± 0.32	0.020	0.157
SRT (m)	450.0 ± 228.0	537.8 ± 210.5 *	498.7 ± 208.3	469.3 ± 162.3	0.046	0.122

Abbreviations: Pre—before intervention; post—after intervention; BMI—body mass index; WHtR—waist-to-height ratio; CMJ—countermovement jump; ST—sprint test; SRT—shuttle run test; η^2 –partial eta squared. * $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$ represent changes from before to after intervention for the IG and CG. p-values represent interaction effects.

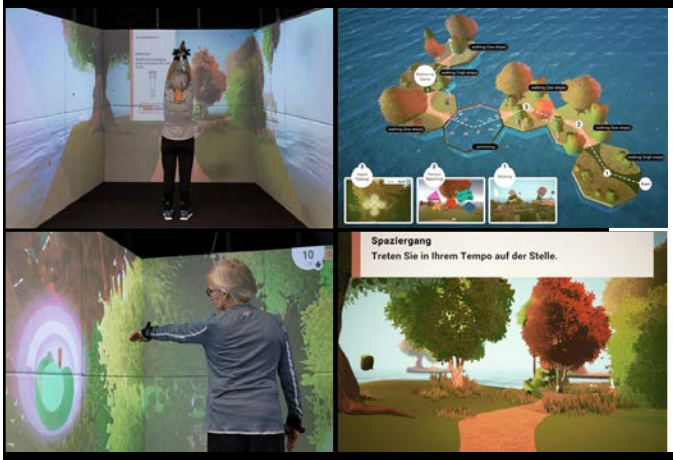
CMJ = Counter movement jumps → sig. increase in IG
SRT = Shuttle run test → sig. increase in IG
ST = Sprint test → sig. increase in IG

WHtR = Waist to hight ratio
BMI = Body mass index

(Ketelhut et al., 2022)

EXTEND

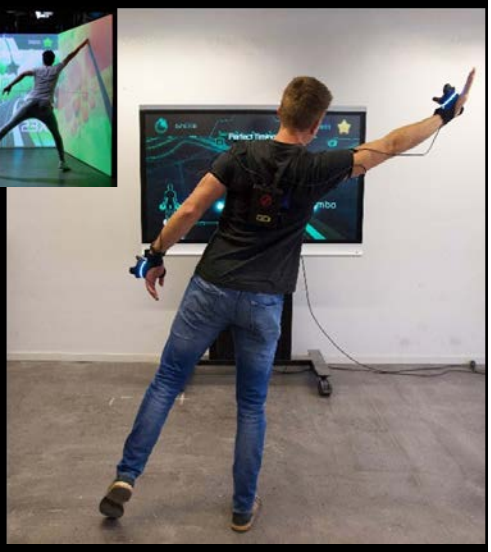
ExerG: Exergame-based Geriatric Therapy



AIM: Adaptation of user-centered soft- and hardware design for the geriatric movement therapy and investigation of accute, and long-term effects on motor-cognitive functions (with relation to every day activities).

AAL Project

ExerCube @Home: On-Body Game Elements



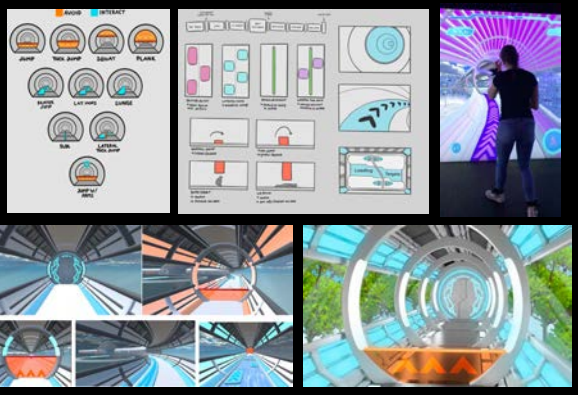
AIM: Exploration of new physically immersive feedback designs for an @home exergame and investigation of long-term physical and cognitive efffects and motivation of a trainingg intervention @home.

Innosuisse Project

ExerUp: Exergame-based Sports Rehabilitation

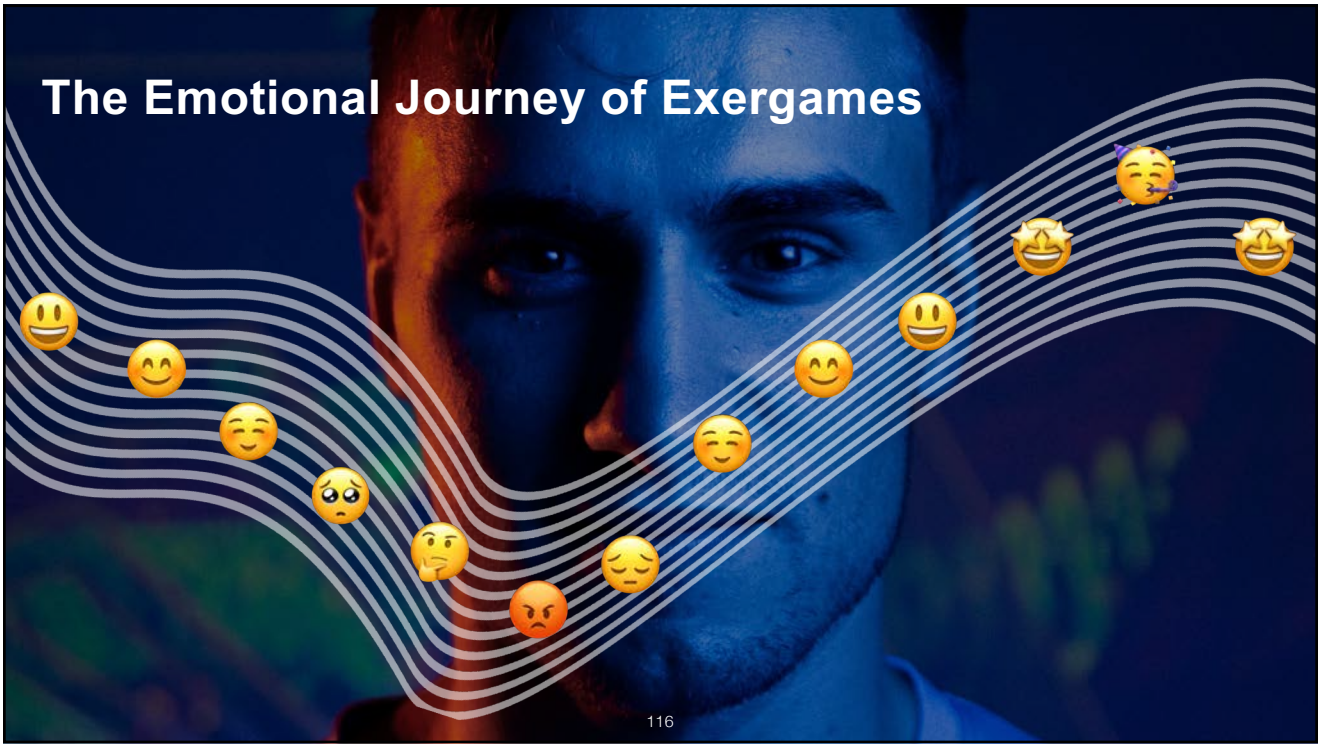
DIZH Project

«Control to Chaos»

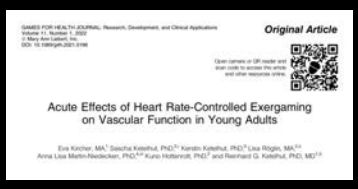


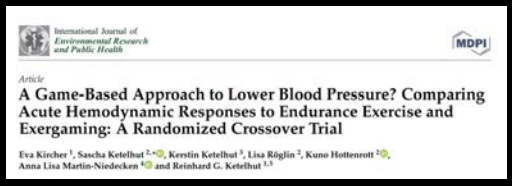
Foci:
- Phase 3 of therapy after knee injury
- Return to sports (control to chaos)

The Emotional Journey of Exergames



Further Studies with the ExerCube





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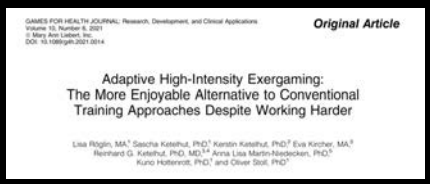
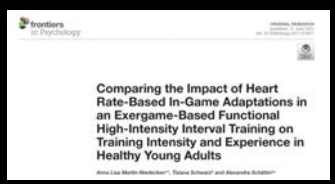
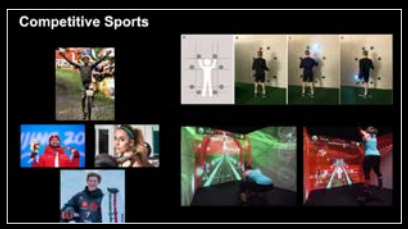




FROM THE LAB TO THE FIELD

Application Areas

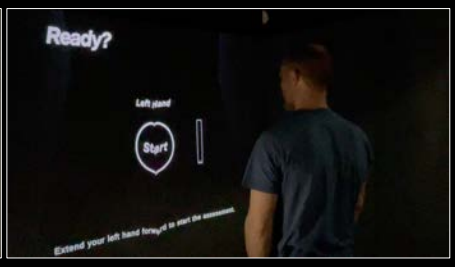


...

Game Selection – Foci

Motor-Cognitive Assessments

Trail Making



Simple Reaction

N Back

8-Weeks Training Plan

David Habluetzel

CONCLUSION

INNOVATION

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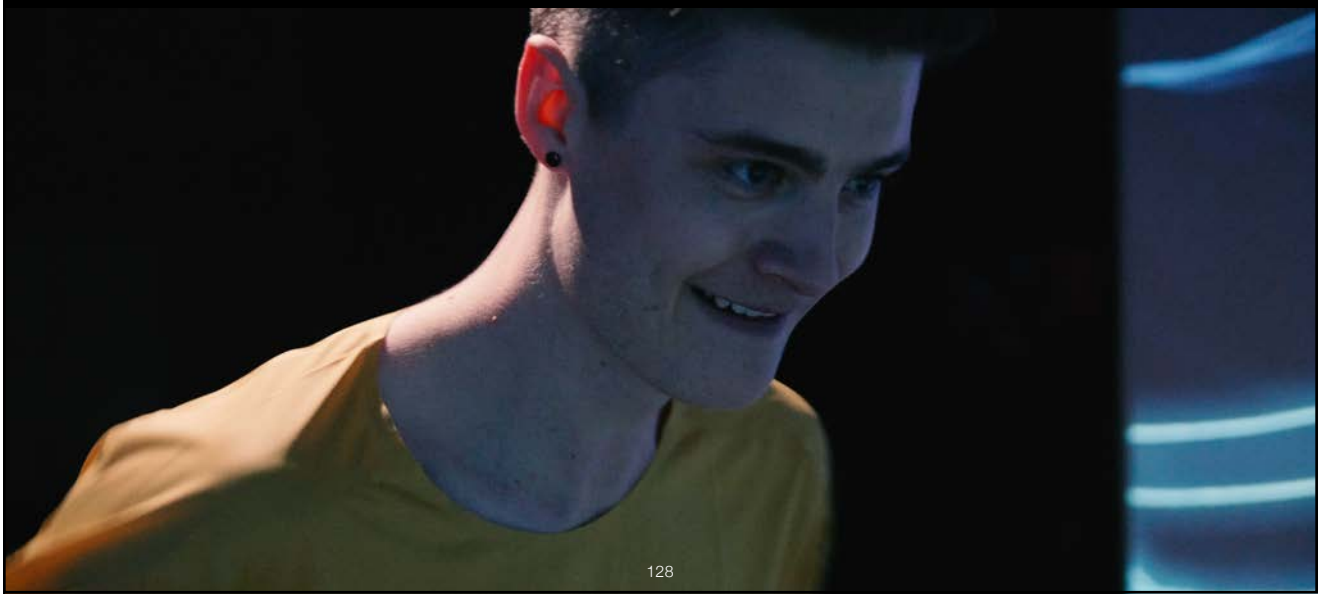
MOTIVATION



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INCLUSION

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EMPOWERMENT

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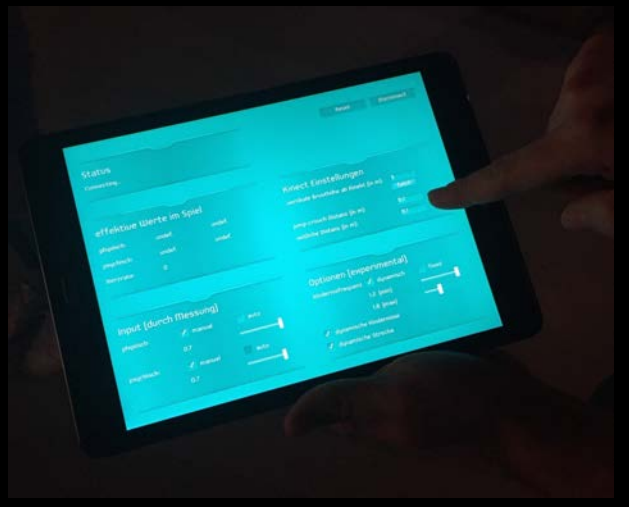
CUSTOMIZATION



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TRAINING BENEFITS

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EMOTIONS

THANK YOU!

Prof. Dr. Anna Lisa Martin-Niedecken

Head of the Institute for Design Research
Department of Design
Zurich University of the Arts (ZHdK), CH

CEO & Founder, Sphery AG

Professor for esports, Sports Science, Health and Digital Innovation
Faculty of Sports Management
University of Applied Management (HAM), GER